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ABSTRACT

A study of the energy usage for 20 St. Cloud (Minnesota) district buildings was completed by a firm of consulting engineers. For each building, the study established a Total Energy Index (TEI) composed of the fuel, electricity, and water consumed during the base line year, fiscal year 1977-78. In addition, the blueprints and any proposed modifications or remodeling plans were also studied. A goal for reduction in energy usage was established for each building of the study. A plan to achieve this stated goal was developed that related potential energy cost-savings to estimated expenditures necessary to achieve the savings. A summary of savings, initial costs, and payback periods for mechanical, electrical, and building envelope categories is included. Recommendations are made that onsite microprocessors be used to control as many of the routine functions as possible. General guidelines and specific recommendations are made to ensure the commitment of district personnel. At the conclusion are recommendations pertaining to one of the secondary buildings. These illustrate what measures of conservation could be utilized by other districts and how they might be used. (Author/MLF)

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CONDUCTING ENERGY AUDITS OF YOUR SCHOOLS

or

"THE LAST ONE OUT OF TOWN, PLEASE TURN OUT THE LIGHTS"

National School Boards Association Convention

San Francisco, California

April 19-22, 1980

EA 012 713

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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Perhaps the sub-title is a bit facetious, however, it does exemplify one approach to energy conservation. Cutting back wherever possible, minimizing usage does achieve conservation. Yet it would be but one segment of a much more complex problem.

Like many school districts, St. Cloud became interested in energy conservation when the fuel shortages of 1973-74 became apparent. Our primary source of fuel, natural gas, was on an interruptable service schedule. This meant on extremely cold days we would be required to switch over to an alternative fuel. With fuel oil in short supply then, we faced the possibility of having an inadequate supply of oil for heating if we were forced to operate for any length of time on oil. We were forced by necessity to look for ways to stretch our supply to meet our need.

Measures such as reduced temperature settings for day and night were implemented. Monitoring of building routines was begun. Even a modified calendar for attendance was ready if the need arose. It brought about an energy awareness as never before.

The crisis passed with minimal hardship but the usage awareness continued. This, coupled with rising costs for fuel, motivated (perhaps pushed would be better) the district into positive action. It should also be noted that at the same time, the State mandated an energy usage study for all State buildings. While not as extensive as what our study would be, it precipitated action on our part.

A contract with Michaud, Cooley, Hallberg, Erickson and Associates, Inc. of Minneapolis was signed in December, 1978. The study was completed in August of 1979 and was a study of the energy usage for 20 of our district buildings. Much of the following data is taken from their study report. At the conclusion of this paper, I have included the recommendations pertaining to one of our secondary buildings. This perhaps best illustrates how and what measures of conservation could be utilized by other districts.

STUDY ANALYSIS

The effectiveness of any conservation measure can only be gauged by a comparison to a given measure of usage. For our base line, we used the fiscal year 1977-1978. For each building, the study established a Total Energy Index (T.E.I.) which was composed of the fuel, electricity and water consumed during that specified time.

The index is formulated by combining all forms of energy and converting them into British Thermal Units (B.T.U.'s). This number divided by the gross area (sq.ft.) of a given building gives you a Total Energy Index for that building. In 1977-1978 the District-wide T.E.I. for the twenty buildings studied totaled 118,935 B.T.U./sq.ft./ year.

In comparing that T.E.I. with other years, several variable factors must also be considered for a comparison to be valid. A building's usage (hours of operation), weather conditions (heating and cooling degree days) are two major factors which could alter the T.E.I. and yet have a comparable Index for any given year.

Having calculated the Total Energy Index for the twenty buildings, a goal for reduction in energy usage was established. Our Consultant Firm projected a possible reduction of the Total Energy Index from 118,935 B.T.U./sq.ft./year to 74,610 B.T.U./ sq.ft./year. This would represent an approximate reduction of 37% in energy usage from our base year.

A plan to achieve this stated goal was developed for each building of the study. The plan would relate potential energy cost-savings to estimated expenditures necessary to achieve the savings. The amount of time necessary before these expenditures would pay

for themselves was specified as the payback time. (Not included in the expenditures were labor and materials which would have normally been used by district maintenance personnel in their day to day routines). The then current costs for fuel/energy were used in this calculation. Between then and now energy/fuel costs have risen significantly and would certainly reduce the payback period for a given modification to become cost effective.

A summary of savings, initial costs and payback periods for mechanical, electrical (lighting) and building envelope categories is included here.

SUMMARY OF SAVINGS/COST

SECONDARY SCHOOLS, AVTI, MEDIA, SERVICES, AND ADMINISTRATION BUILDING

ITEM	ELECT. KWH/YR.	FUEL MMBTU/YR.	WATER GAL./YR.	TOTAL SAVINGS $/YR	ESTIMATED FIRST COST $	PAYBACK PERIOD
I. MECHANICAL						
1. Plumbing	9,744	785.5	2,310,966	5,403	6,788	1.3 Years
2. Boiler/ Chill. System	23,547	7,906.0		19,107	113,120	5.9 Years
3. HVAC	255,051	10,478.0		37,453	7,200	2.3 Months
4. Exhaust Fans	66,688	4,577.0		15,933	350	.3 Months
5 Total Mechanical	355,030	23,746.5	2,310,966	77,896	127,458	1.6 Years
II. ELECT./LIGHTING						
1. Lighting	1,682,988			51,887	397	.1 Months
III. BUILDING ENVELOPE						
1. Modifications	13,308	32,720		82,904	2,491,060	30 Years

SUMMARY OF SAVINGS/COST - ELEMENTARY SCHOOLS

ITEM	ELECT. KWH/YR.	FUEL MMBTU/YR.	WATER GAL./YR.	TOTAL SAVINGS $/YR.	ESTIMATED FIRST COST $	PAYBACK PERIOD
I. MECHANICAL						
1. Plumbing	2,344	229	1,687,509	2,845	2,458	.9
2. Boiler Operation	18,966	1,550		4,775	44,500	9.3
3. HVAC	76,346	1,073		4,894	500	.1
4. Exhaust Fans	17,203	1,740		6,280	1,400	.2
5. Total Mechanical	114,859	4,592	1,687,509	18,794	48,858	2.6
II. ELECT./LIGHTING						
1. Lighting	439,486	-		15,271	9,410	.6
III. BUILDING ENVELOPE						
1. Modifications	2,035	8,477		28,669	1,725,850	60.2

It is obvious from this summary that the payback period for building envelope modifications is significantly greater (longer) than for any of the other possible energy conservation measures. However, as energy costs continue to increase, this payback period will decrease making building envelope retro-fitting more attractive. It is likewise obvious that by concentrating on mechanical/electrical modifications, a greater energy savings will also result. Thus the recommendation made from our study was for the most part to leave building envelope retro-fitting to a time of planned renovation and remodeling.

ENERGY STUDY OF INDIVIDUAL BUILDINGS

A review of the past eighteen months' records on electricity, fuel and water consumption for each building was the first step in the individual studies. In addition the blueprints and any modifications or remodeling plans were also studied. A verification of the collected data was accomplished by a walkthrough inspection of each building and equipment within the building. Additional information was collected in conversations with maintenance personnel.

Not all the information requested was readily available. In some instances the information was not accurate or current. It is worth noting, at least from our experience, that an essential part of a management and maintenance program in energy conservation necessitates amplified and current records. Specifically, our study said:

1. Plans, specifications, shop drawings and balancing records for individual machines should be kept.
2. Actual measurements of C.F.M., G.P.M., R.P.M., volts, amps, pressures, etc. of equipment as it is presently operating and as it is cut back in operation should also be available.
3. Lubrication types and schedules should be posted and available.
4. Replacement parts required and where they may be acquired should be known.
5. Each piece of equipment should have a maintenance record card.

Following the on-site inspections, all data was collected and tabulated for future calculations. The two tables of data here illustrate the base from which energy reduction recommendations were made for one of our secondary school buildings.

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& Associates, Inc.
310 Plymouth Building
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Table No. 1-1 -- Area Breakdown
Building Inventory - Mechanical/Electrical
and Energy Utilization Survey

NAME OF BUILDING	Technical High School
YEAR BUILT/ADDITION	16/36 55 63 75
REMAINING USEFUL LIFE (See Note 2)	62 66 74 86
NO. OF STORIES	3
AREA BREAKDOWN SQ. FT.	
CLASSROOMS (+ Music)	106,817
ADM. OFFICES	12,669
AUDITORIUM/Stage Areas	4,312
GYMNASIUM/Gymnastics/Locker rm/Showers	35,727
KITCHEN/DINING/SERVING	15,096
ENC. SWIMMING POOL	9,785
SHOPS	28,935
ALL SERVICE AREAS	131,652
GROSS AREA	344,990

NOTE 1: The preceding data is based on the drawings, so it may very slightly from other records.

NOTE 2: The above table gives the remaining useful life of Technical High School according to the estimates from the Minnesota Builder's Appraisal Manual (1968/1975 edition) based on an assumed life span of 95 years for buildings in normal condition less an effective age corrected according to MBAM tables for any remodeling or addition. A payback period for any modification must be less than the remaining life to be at all economically feasible.

Michaud, Cooley, Hallberg, Erickson
& Associates, Inc.
Minneapolis, MN 55402

Table No. 1-3
Annual Usage/Cost
Analysis: Year - 12 Months
1977-1978

NAME OF BUILDING	Technical High School
GROSS AREA - SQ. FT.	344,990
USAGE - ELECT - KWH	1,962,680
VARIANCE FROM L.Y. - %	
FUEL OIL - GAL	90,484
FUEL OIL - MMBTU	12,668
INT. GAS - MCF	22,010
FIRM GAS - MCF	308
TOTAL FUEL - MMBTU	34,986
VARIANCE FROM L.Y. - %	
USAGE INDEX	
ELECT. - KWH/#	5.69
ELECT. - BTU/#	19,428
FUEL - BTU/#	101,412
TOTAL ENERGY (TEI) - BTU/#	120,840
COSTS - ELECT. - $	74,994
FUEL OIL - $	34,383
INT. GAS - $	34,599
FIRM GAS - $	741
TOTAL - $	144,717

Another interesting fact came to light as the electrical power systems of our secondary schools were studied. It became apparent that a significant savings could result by the installation of Factor Correction Capacitors in two of our secondary buildings. Initial investment of $15,700 for Technical High School gave us a payback period of only 3.2 years. This recommendation is now being implemented by the school district. (Another interesting side note became evident. Many larger users of electricity have their rate determined by their peak usage. By staggering kick-in times, we were able to reduce our peak demand, thus obtaining a lower rate from the utilities company).

COMPUTERIZATION

In any cost effectiveness program accurate and readily available records are essential. To facilitate this we have this past year implemented a computerized monthly energy monitoring and analysis program for each building. This program provides:

> "Information relating to the electrical/fuel usage and costs for the current month, percentage deviation from last year for the same month, present unit cost and percent variation from last year for the same month, Electrical Utilization Index (E.U.I.), Total Energy Index (T.E.I.), Heating Utilization Index (H.U.I.), based on the degree days, energy budget for the month and percent deviation from actual, etc. The data sheet assists management in analysis of the data of various buildings on various units of comparison, considering are, geography, climatology (degree days), operating hours and rate structures. Year-to-Date (YTD) sheet assists in establishing budgets, forecasting, etc."

Data processing of another mode was suggested by our study. Presently much of the day to day routine scheduling of lights and equipment is facilitated by manual means. However, there is a limit to cost effectiveness achieved through this mode of

operation. The ever increasing complexity of equipment, the variation of external conditions (weather) necessitating changes in procedure and the addition of new conservation procedures certainly indicates need for automation wherever possible.

Without going into greater detail, it was suggested by our study that on-site micro-processors be used in our secondary schools to control as many of the routine functions as possible which would thereby alleviate the need for manual operation in many areas. Micro-processors would be used to operate start/stop functions and duty cycling of air handling equipment.

PERSONNEL COMMITMENT TO ENERGY USAGE CONSERVATION

Building utilization, equipment effectiveness, procedural evaluations are all important to energy conservation or reduction. But of great importance to any reduction in Total Energy Index is the commitment of District personnel. Students, faculty, Board, and maintenance people all must be involved and share the responsibility for energy conservation. A "Discipline of Operation" by all involved will be a major factor in controlling usage and effecting any reduction in consumption. Likewise, new ideas for further reduction must come from more than just management or operating personnel.

People's attitudes will play a significant role in the reduction of the Total Energy Index. The saying, "if they are not with you, they are against you", is surely true here. A positive attitude about conservation is essential. The feeling or the question "What will I have to sacrifice if these changes are implemented?" has to be answered. Our study stressed that: "A significant amount of energy and cost savings could be realized with a rational approach and enforcement of 'Discipline in Operations' programs without sacrificing much of the comfort conditions."

If people know and believe this and have an awareness and an understanding of what is expected of them, positive attitudes are more likely to be realized. Our study stressed the importance of general guidelines being established for:

1. Operation during non-occupancy hours and during holiday periods.
2. Operation and energy usage during occupancy hours.
3. Preventative maintenance programs.
4. Good housekeeping techniques.
5. Employee education and cooperation.

Specific recommendations for each of these were made, some of which I will list here:

A. Building Activity/Operation Schedule:

1. Establish an activity schedule for each building as well as each department or area within the building.
2. Establish a procedure on scheduling on-off operation for lighting, HVAC fans and exhaust fans.
3. Establish building cleaning schedules.
4. Establish A.C. fan/unit and exhaust fan operating hours as per occupancy schedule and as per ambient weather data.

B. Reduce Energy Usage During Occupancy Hours:

1. Reduce excessive lighting levels. Turn off lighting during daylight hours near windows and under skylight areas.
2. Reduce HVAC unit operating hours.
3. Reduce humidity settings to the minimal requirements of the process or machine or for human health.
4. Raise discharge air temperature of all fan systems to save cooling.

5. Reduce the quantity of minimum outside air used for ventilation. Reset the damper positions to satisfy ventilation needs of human occupancy and building exhaust requirements.

6. Reduce outside make-up air and exhaust air quantities.

C. Reduce Operation During Non-Occupancy:

1. Reduce cleaning period and reduce cleaning period lighting levels.

2. Curtail the usage of HVAC systems (supply fans, ventilators, exhaust fans, pumps, etc.)

3. Turn off or minimize lighting usage (except minimum for security) during unoccupied periods, nights, summers and holidays.

D. Preventive Maintenance Program:

1. Maintain a scheduled preventive maintenance program of inspection, cleaning, lubrication, adjustment and tightening of various components of the rotating machinery.

2. Regular filter change.

3. Clean, adjust and run combustion checks on all boiler burners once each year.

4. Install access doors where required, and thoroughly clean all heating and cooling coils once per year.

5. Periodically remind cleaning staff to turn off exhaust fans in unoccupied areas.

E. Good Housekeeping

1. Clean up of dirty light fixtures, lamps and lens.

2. Educating students and faculty to use room switches to turn off lights when the room is vacant.

3. Use drapes on outside windows in offices and classrooms, particularly on sunny days in summer and cold winter nights.

4. Instruct all occupants not to open windows when heating or cooling systems are operating.

F. Kitchen and Cafeteria Areas - Good Housekeeping

1. Inspect walk-in coolers/freezers and reach-in refrigerators which lack automatic closers or tight door gaskets.
2. Train kitchen staff in conservation of hot water. Supervise their performance and provide additional instruction and supervision as necessary.
3. Keep refrigeration coils free of frost build-up.
4. Cook with lids in place on pots and kettles. It can cut heat requirements in half.
5. Fans that cool workers should be directed away from heated kitchen equipment.
6. Consider using microwave ovens for thawing and fast food preparation whenever they can serve to reduce power requirements.

G. Education and Cooperation

1. Obtaining cooperation: The importance of the employee contribution to the overall energy conservation program cannot be emphasized enough.
2. It is suggested that you establish which changes which will involve district employees either directly or indirectly. Meet with whomever is in charge of each school or department. If feasible, present specific data relating to energy and operating costs of building involved. Begin discussion with an explanation of the changes, expected energy cost increases and what management is prepared to do. Emphasize that many of the undertakings will require their cooperation. Identify each undertaking, trying to be as flexible as possible, especially when the items concerned are of relatively low priority. Where items are important, however, try to be as firm as possible. Under no circumstances should merely a note be sent stating

that a given change will be made (whether one likes it or not). Personal contact is essential. An explanation of what is being done is essential.

3. Inform all administration, faculty and custodial personnel of impending changes and the way in which they can be of help.
4. The use of signage can also be of assistance. Signs such as PLEASE BE SURE DOOR IS CLOSED SECURELY, PLEASE TURN OFF LIGHTS WHEN ROOM IS NOT IN USE, etc., placed in strategic locations, can be most helpful.
5. Campaign for better utilization by using letters, memos, signage, and personal contact to encourage use of lighting only as it is required and to turn off lights whenever they are not being used.
6. Post a small sign or chart near each switch which identifies which lights are controlled by which switch. This enables the user to be more selective while also reducing trial-and-error which can consume significant amounts of energy as banks of lights are quickly activated and deactivated.
7. Through letters, memoranda, signage, personal contact and other means, encourage all administrative personnel and faculty to turn off all electric equipment not in use, including portable fans, typewriters, calculators, coffee pots, copy equipment, etc.
8. Maintain continual contact and involvement with school administration and faculty. Let them know that their efforts and cooperation are paying off.

CONCLUSION

Not all of the items mentioned in this paper will be useful to everyone. Perhaps you will have found some items, such as attitudinal measures or specific change items which can be of help to you. One thing became quite clear to us, knowing what is before any changes are made. A thorough study is most beneficial in this regard.

Energy audits are an investment, not merely a cost. Our initial cost was approximately $108,000.00.

Since our energy study we have applied for state and federal grants to implement changes. Here again our study was of great value. This past month, we have received notification that some of our grant proposals were accepted. We have been awarded grants totaling $239,257.00.

BUILDING RECOMMENDATIONS

As I mentioned earlier, I have included the recommendations from the study for one of our secondary buildings. You will see from the individual items, the savings, the estimated cost and the anticipated payback period.

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AND ASSOCIATES, INC.
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S-3
ENERGY CONSERVATION
COST/BENEFIT SUMMARY

Owner:
Bldg. Name Tech. H.S.
Bldg. Location

Date:

Sec. NO.	REF. NO.	SPECIFIC CONSERVATION ITEM	ELECT. SAVINGS KWH/YR	FUEL SAVINGS MMBTU/YR	ENERGY SAVINGS $/YR	MODIFICATION COST $	PAYBACK PERIOD YRS	Water & Sewer Savings Gals.
3.3	A-1a	Lower H.W. Temp to 110°F.	-	138	437	-	Immed.	
3.3	A-2	Lower Aquastat setting to 100°F	1,719	-	31	-	Immed.	
3.3	A-3	Install flow restrictors on lavatories	-	61	334	370	1.1	12,271
3.3	A-4	Install water savers on water closets	-	-	421	615	1.5	366,300
		PLUMBING TOTAL	1,719	199	1,223	985	.8	378,571
3.3	B-1a	Install gas-fired domestic & pool htr. Turn off boiler	-	2,727	4,878	9,400	1.9	
3.3	B-2	Reduce chiller operation & increase space temp.	9,800		176	-	Immed.	
		HEATING/COOLING SYSTEM TOTAL	9,800	2,727	5,054	9,400	1.9	
3.3	C-1a	Reduce operating hours of A.H. unit	69	-	1	-	Immed.	
3.3	C-1b	Reduce minimum outside air requirement	55	-	1	-	Immed.	
3.3	C-2a	Reduce day cycle hours	2,686	34	156	-	Immed.	
3.3	C-2b	Revise controls	-	125	396	200	.5	
3.3	C-5	Reduce day cycle hours	17,456	19	374	-	Immed.	
3.3	C-6a	Reduce day cycle hours	7,600	59	324	-	Immed.	
3.3	C-6b	Reduce minimum fresh air	-	96	304	200	.7	
3.3	C-7	Disconnect interlock with exhaust fan	2,481	238	799	200	.3	
3.3	C-8a	Reduce day cycle hours on S-2	20,142	272	1,225	500	.4	
3.3	C-8b	Reduce minimum fresh air	-	103	327	200	.6	
3.3	C-10	Reduce day cycle hours	19,790	439	1,748	-	Immed.	
3.3	C-11	Reduce day cycle hours	4,856	58	271	-	Immed.	
3.3	C-13a	Reduce day cycle hours	5,375	73	328	-	Immed.	
3.3	C-13b	Reduce minimum fresh air	907	116	384	200	.5	
3.3	C-14a	Reduce day cycle hours	1,772	5	48	-	Immed.	

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Bldg. Name Tech. H.S.
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Sec. NO.	REF. NO.	SPECIFIC CONSERVATION ITEM	ELECT. SAVINGS KWH/YR	FUEL SAVINGS MMBTU/YR	ENERGY SAVINGS $/YR	MODIFICATION COST $	PAYBACK PERIOD YRS	Water & Sewer Svgs. Gals.
3.3	C-14b	Reduce minimum fresh air	249	32	105	200	1.9	
3.3	C-15	Repair control system	-	1,524	4,831	200	.1	
3.3	C-17	Reduce day cycle hours	1,242	34	130	-	Immed.	
3.3	C-18	Reduce day cycle hours	470	4	21	-	Immed.	
		A.H. units TOTAL	85,150	3,231	11,773	1,900	.2	
3.3	D-1	Reduce operating hours of exhaust fans	67	6	20	-	Immed.	
3.3	D-2	Reduce operating hours of exhaust fans	430	93	303	-	Immed.	
3.3	D-3	Reduce operating hours of exhaust fans	2,075	207	693	-	Immed.	
3.3	D-4	Reduce operating hours of exhaust fans	1,731	-	31	-	Immed.	
		EXHAUST FANS TOTAL	4,303	306	1,017	-	Immed.	
		TOTAL MECHANICAL SAVINGS	100,972	6,463	19,097	12,285	.6	378,571
1.3	A-1	Eliminate ext. canopy lites	2,190	-	74	-	Immed.	
1.3	A-2	Reduce operating hours	12,763	-	230	-	Immed.	
1.3	A-3	Reduce operating hours	511	-	9	-	Immed.	
1.3	B-1	Use 50% ltg. or remove 1/2 lamps and ballasts	10,673	-	363	-	Immed.	
1.3	B-2	Remove two lamps & ballast per fixture	1,274	-	43	-	Immed.	
1.3	B-3	Remove lamps and ballasts per fixture	39,710	-	1,350	-	Immed.	
1.3	B-4	Remove lamps and ballasts	1,620	-	55	-	Immed.	
1.3	B-5	Remove lamps and ballasts	1,699	-	58	-	Immed.	
1.3	B-6	Remove lamps and ballasts	5,487	-	186	-	Immed.	
1.3	B-7	Remove lamps and ballasts	2,124	-	72	-	Immed	
1.3	B-8	Replace existing quartz with lower wattage	915	-	32	207	6.5	

Ref. No. = Manual Paragraph No.

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Owner:
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Sec. NO.	REF. NO.	SPECIFIC CONSERVATION ITEM	ELECT. SAVINGS KWH/YR	FUEL SAVINGS MMBTU/YR	ENERGY SAVINGS $/YR	MODIFICATION COST $	PAYBACK PERIOD YRS	
4.3	B-9	Remove lamps and ballasts	21,028	-	715	-	Immed.	
4.3	B-10	Replace existing incand. with lower wattage	319	-	11	-	Immed.	
4.3	B-11	Remove lamps and ballasts	3,398	-	115	-	Immed.	
4.3	B-12	Remove lamps and ballasts	7,222	-	245	-	Immed.	
4.3	B-13	Remove lamps and ballasts and do not use incand.	8,566	-	291	-	Immed.	
4.3	B-14	Remove lamps and ballasts	354	-	12	-	Immed.	
4.3	B-15	Remove lamps and ballasts	4,368	-	148	-	Immed.	
4.3	B-16	Remove lamps and ballasts	2,209	-	75	-	Immed.	
4.3	B-17	Remove lamps and disconnect ballasts	31,860	-	1,083	-	Immed.	
4.3	B-18	Remove lamps and ballasts	7,731	-	263	-	Immed.	
4.3	B-19a	Remove lamps and disconnect ballasts	26,331	-	895	-	Immed.	
4.3	B-19b	Discontinue use of underwater lights	69,300	-	2,356	-	Immed.	
4.3	B-20	Remove lamps and ballasts	9,824	-	334	-	Immed.	
4.3	B-21	Remove lamps and ballasts	5,416	-	184	-	Immed.	
4.3	B-22	Remove lamps and ballasts	471	-	16	-	Immed.	
4.3	B-23	Remove lamps and ballasts	212	-	7	-	Immed.	
4.3	B-24	Remove lamps and ballasts	1,912	-	65	-	Immed.	
4.3	B-25	Remove lamps and ballasts	756	-	26	-	Immed.	
4.3	B-27	Remove lamps and ballasts	17,201	-	585	-	Immed.	
4.3	B-28	Remove lamps and ballasts	756	-	26	-	Immed.	
4.3	B-29	Remove lamps and ballasts	16,992	-	578	-	Immed.	
		LIGHTING TOTAL	315,228	-	10,502	207	Immed.	

Ref. No. = Manual Paragraph No.

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AND ASSOCIATES, INC.
CONSULTING ENGINEERS
MINNEAPOLIS, MINNESOTA 55402
612-339-4941

S-3
ENERGY CONSERVATION
COST/BENEFIT SUMMARY

Owner:
Bldg. Name Tech. H.S.
Bldg. Location
Date:

Sec. NO.	REF. NO.	SPECIFIC CONSERVATION ITEM	ELECT. SAVINGS KWH/YR	FUEL SAVINGS MMBTU/YR	ENERGY SAVINGS $/YR	MODIFICATION COST $	PAYBACK PERIOD YRS	
5.4	5-2	Roof Modification for 1916 Building	-	666.5	2,126	65,000	31	
		" " " 1938 Addition	1,148	1,874.4	6,000	52,000	9	
		" " " 1955 Addition	736	725	2,326	72,000	31	
		" " " 1975 Addition (Cafeteria)	54	24.7	80	10,000	125	
		" " " 1963 Addition	376	406.4	1,303	113,000	87	
		" " " 1963 (Media Addition)	44	58.1	186	12,000	65	
		" " " 1975	-	444.8	1,419	125,000	88	
		" " " 1975 (Media Addition)	-	17.5	56	5,600	100	
5.4	5-3	Wall Modification 1916 Building	-	723.6	2,308	66,000	29	
5.4	5-3	" " 1938 Addition	210	637.5	2,021	47,000	23	
5.4	5-3	Window Modification 1955 Addition	94	499.5	1,595	50,000	31	
5.4	5-3	" " " "	-	29.4	94	3,000	32	
5.4	5-3	" " " "	4	7	22	900	41	
5.4	5-3	Door Sidelight Modification - 1955 Addition	-	30	96	2,500	26	
5.4	5-3	Window Modification - 1955 (Cafeteria)	165	88.9	287	6,700	23	
5.4	5-4	Wall Modification - 1955 Addition	-	232	740	22,000	30	
5.4	5-4	Window Modification - 1963 Addition	-	287.3	916	21,000	23	
5.4	5-4	" " " "	-	352.1	1,123	36,000	32	
5.4	5-4	" " " "	-	26.2	83	3,500	42	

Ref. No. = Manual Paragraph No.

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S-3
ENERGY CONSERVATION
COST/BENEFIT SUMMARY

Owner:
Bldg. Name Tech. H.S.
Bldg. Location
Date:

Sec. NO.	REF. NO.	SPECIFIC CONSERVATION ITEM	ELECT. SAVINGS KWH/YR	FUEL SAVINGS MMBTU/YR	ENERGY SAVINGS $/YR	MODIFICATION COST $	PAYBACK PERIOD YRS	
5.4	5-1	Window Modification - 1963 Addition	-	81.8	271	6,100	23	
		" " " "	909	19	77	3,200	42	
		Door Sidelight Modification - 1963 Addition	-	71	226	5,800	26	
		Wall Modification - 1963 Addition	187	279.1	894	38,000	43	
		" " " " (Media)	16	23.1	74	2,500	34	
		TOTAL BUILDING ENVELOPE SAVINGS	3,943	7602.4	24,323	768,800	31.6	
6	C-5	Automation - Start-Stop	61,259	796	3,676			
		Duty Cycle	14,693	376	2,003			
		TOTAL			5,679	10,000	1.8	

Ref. No. = Manual Paragraph No.

3.3 TECHNICAL HIGH SCHOOL

A. Plumbing

1. Domestic water heaters

Present operation: Domestic H.W. provided by:

(a) 2 steam convertors for east wing.

- H.W. temperature observed at 135°.
- One convertor shut off during summer

(b) 1 steam convertor for west wing.

- H.W. temperature observed at 138°.

(c) 1 steam convertor for kitchen area.

- Used during school year.

Recommendations:

(a) Lower H.W. temperature to 110°.

Savings: 8 1/3 BTU/gal. x 25° x (2,035 students x 1.8 gal./student x 180 days + 50 students x 1.8 gal./student x 50 days) = 138 MMBTU/yr. @ $3.17/MMBTU = $437/yr.

First cost: None

Payback: Immediate

(b) Install small electric water heater for west wing office area and shut off steam convertor for this wing in order to reduce piping and tank heat loss and circulating pump operation.

Savings: Difficult to determine, however, we anticipate a relatively short pay back period.

2. Domestic H.W. recirculation pumps

Present operation: Aquastats observed set on 160 - 200°. Pumps run continuously M-F.

Recommendations: Lower aquastat settings to 100°.

Savings: Assume pumps will be off 50% of the time.

.9 HP x .746 x 180 days x 12 hrs. + .5 HP x .746 x 60 days x 12 hrs. = 1,719 KWH/yr. @ $.018/KWH = $31/yr.

First cost: None

Payback: Immediate

3. Lavatories

Recommendations: Install flow restrictors on 74 lavatories to limit flow rate to .5 GPM.

Savings: Assuming 1.5 GPM flow rate of existing faucets, restrictors will provide 67% savings in hot water usage.

Water & sewer savings:

.5 gal./day/person x 180 days x 2,035 students x .67 = 12,271 ga./yr.
@ $1.15/1,000 gal. = $141/yr.

Fuel savings:

122,711 gal. x (110-50) x 8 1/3 BTU/gal. = 61 MMBTU
@ $3.17/MMBTU = $193/yr.

First cost: 74 lavatories @ $5 = $370. These devices are simple to install, so maintenance staff can do the work.

Payback: 1.1 yrs.

4. Water closets

Recommendations: Install water savers in water closet flush valves to reduce water consumption by one gal./flush.

Savings: Assume on flush/student/day.

2,035 students x 180 days x 1 gal. = 366,300 gal./yr.
@ $1.15/1,000 gal. = $421/yr.

First cost: 82 water savers @ $7.50 = $615.

Payback: 1.5 yrs.

B. Heating/cooling system

1. Boiler operation

Present operation: Two steam boilers using interruptible gas with #2 oil for stand-by are used during heating season. A third steam boiler using interruptible gas with #2 oil for stand-by is used 11 months/year to provide heat for pool and domestic hot water in addition to satisfying building

heating and ventilation requirements. Heating mains are valved off during summer.

Recommendations: Install gas fired water heater and gas fired pool heater and shut boilers off during the summer.

(a) Water heater

Our calculation indicates approximately 800 GPH recovery required. We estimate usage to be 1.8 gal./ student x [2,035 students x 19 days (Sept.) + 50 students x 65 days (June-Aug.)] x 8 1/3 BTU/gal. x (110-50) = 39 MCF/.70 eff. = 54 MCF cost of heating water with firm gas @ $2.65/MCF = $143.

(b) Pool heater

Our calculations indicate approximately 120,000 BTUH heater required. We estimate usage to be 114 MCF. Heating cost with firm gas @ $2.65 = $315.

Savings:
770 MCF used 5/30/78 - 6/28/78
540 MCF used 6/28/78 - 7/28/78
530 MCF used 7/28/78 - 8/28/78
1060 MCF used 8/28/78 - 9/27/78

2900 MCF @ $1.84 = $5,336.

2,900 MCF	$5,336	
-54 MCF	143	- summer water heater
-119 MCF	315	- summer pool heater
2,727 MCF saved	$4,878	saved

First cost:

Domestic water heater	$4,500
Pool heater	4,900
Total cost	$9,400

Payback: 1.9 yrs.

2. Chiller operation

Present operation: 100 ton reciprocating chiller is run approximately 2-3 weeks in spring and 6 weeks in fall. Chiller is used to cool resource center which is occupied throughout school year, one week before school starts, and one week after school ends. Chiller is turned on at 7 or 8 am when room temperature is at 73 or 74° and is turned off at 3:30 pm. Cooling stats observed set at 75° F. in resource center. A 200 ton reciprocating chiller is being added and chilled water will also be pumped to classroom and lecture room units.

Recommendations: Reset Cooling stats to 78° F. Do not start chiller until room temperature is above 78° F. and turn chiller off at 3 pm.

Savings: Assume 100 hrs. reduction in chiller operating hrs. and 50% average load.

100 tons x 100 hrs. x .50 = 5,000 ton-hrs.
@ 1.4 KW/ton-hr. = 7,000 KWH
@ $ .018/KWH = $126/yr.

Assume 20% reduction in cooling by resetting thermostat.

100 tons x 50% average load x .20 x 200 hrs. = 2,000 ton-hrs.
@ 1.4 KW/ton-hr. = 2,800 KWH
@ $.018/KWH = $50/yr.

First cost: None

Payback: Immediate

C. Air handling systems/units

1. AC-1 Attendance office

Present operation: Unit runs from 7 am - 4 pm M-F during summer months when unit S-2 is off.

- Roof-top DX cooling and ventilation unit.
- Economizer controlled FA/RA dampers designed for 10% minimum fresh air.
- Thermostat was not installed, so unit has been run manually. (Maintenance engineer just received stat).

Recommendations:

(a) Do not start unit until 8am.

Savings: 2.83 HP x .746 x 13 wks. x 5 days x 1 hr. x .5 = 69 KWH/yr.
@ $.018/KWH = $1/yr.

(b) Lower minimum fresh air setting to 5%.

Savings: 1,350 CFM x .05 x 4.5 x 6 x 13 wks. x 5 days x 8 hrs. x 50% = 39 ton-hrs.
@ 1.4 KW/ton-hr. = 55 KWH/yr.
@ $.018/KWH = $1/yr.

First cost: None

Payback: Immediate

2. S-1 & S-2 Classrooms - 1916 & 1938 buildings

Present operation: Units run on day cycle 7 am - 3:30 pm M-F during school year.

. V.A.V. ventilation units.

. 100% recirculation until return air temperature is 65° and then FA/RA dampers controlled to maintain 65° supply temperature when outside temperature is -10° or below. Maintains 55° supply when outside temperature is 40° or higher, and modulate between these two points.

. Chilled water cooling is being added this summer.

. Space stats control radiation and air valves.

Recommendation:

(a) Do not turn units to day cycle until classes begin at 8 am.

Savings: Fan energy:

40 HP x .5 x .746 x 180 days x 1 hr. = 2,686 KWH/yr.
@ $.018/KWH = $48/yr.

Heat energy: Assume an average of 10% fresh air due to damper setting and/or leakage.

56,000 CFM x .10 x 1.08 x (68-28) x 28 wks. x 5 days x 1 hr. = 34 MMBTU/yr.
@ $3.17/MMBTU = $108/yr.

First cost: None

Payback: Immediate

(b) Re-adjust controls to maintain 65° supply temperature when outside temperature is below 30° and 55° supply when outside temperature is above 50°

Savings: This will reduce the fresh air an average of 4% when the outside temperature is between -10° and 30° and reduce the heating requirement by 10° between 40° and 50° outside temperature.

56,000 CFM x .04 x 1.08 x (68-65) x 580 hrs. + (56,000 cfm x 1.08 x 10° x 200 hrs.) = 125 MMBTU
@ $3.17/MMBTU = $396/yr.

First cost: Assume $200 to adjust, recalibrate & check out controls.

Payback: 6.1 months

3. S-3 Lecture rooms

Present operation: Unit is run on day cycle only when rooms are occupied. (an average of 40 hrs. per month).

Recommendations: None

4. AC-4 Auditorium

Present operation: Unit is run on day cycle only when auditorium is occupied. (Approximately one mo./yr.).

Recommendations: None

5. S-1 Locker Rooms

Present operation: Unit runs on day cycle from 11 pm Sunday to 5 pm Saturday during school year and 7 am - 11 pm M-F during summer (2 months).

- Single zone air handling unit w/H.W. coils in supply ducts.
- Heat recovery wheel handles 1/3 of total air supply when outside temp. is below 50°.
- FA to heat wheel is preheated to 0° by steam coil.

Recommendations: Turn system off during unoccupied hours.

Savings: Fan energy:

(7 1/2 HP x .746 x 60 hrs. x 36 wks.) + (5 HP x .746 x 20 wks. x 60 hrs.) + (7 1/2 x .746 x 20 hrs. x 8 wks.) = 17,456 KWH/yr.
@ $.018/KWH = $314/yr.

Heat energy:

5,000 CFM x 1.08 x (0-7) x 90 hrs. + 5,000 CFM x 1.08 x (65-56) x 300 hrs. = 19 MMBTU
@ $3.17/MMBTU = $60/yr.

First cost: None

Payback: Immediate

6. S-1 & S-2 Resource center

Present operation: Units run on day cycle from 6:30 am - 4 pm M-F from about one week before school starts until

one week after school ends.

- Single zone units w/chilled water coils and H.W. reheat coils in supply ducts. - Reheat system used only during heating season.
- S-2 has variable volume inlet vanes.
- Space stats throttle air valves to 50% and then open coil valves.
- 10% minimum fresh air after warm-up cycle.
- System have enthalpy controls.
- Stats in key rooms control 3-way valves on cooling coils.
- Units cycle on U.H. cycle in night mode.

Recommendations:

(a) Vary time of switching to day cycle with outside temperature. During moderate weather, units should be switched to day cycle at 8 am. Turn units to night cycle at 3 pm.

Savings: Fan energy: Assume 1 1/2 hrs. reduction in running time in Dec., Jan., Fab., 2 hrs. in Nov. and March and 2 1/2 hrs. in Aug., Sept., Oct., April, May & June.

25 HP x .746 x [(12 wks. x 5 days x 1 1/2 hrs.) + (8 wks. x 5 days x 2 hrs.) + (19 wks. x 5 days x 2 1/2 hrs.)] = 7,600 KWH/yr.
@ $.018/KWH = $137/yr.

Heat energy: Assume 15% fresh air due to dampersetting and/or leakage.

39,700 CFM x .15 x 1.08 x [(68-16 x 12 wks. x 5 days x 1 1/2 hrs.) + (68-36 x 8 wks. x 5 days x 2 hrs.) + (68-48 x 8 wks. x 5 days x 2 1/2 hrs.)] = 59 MMBTU
@ $3.17/MMBTU = $187/yr.

(b) Reduce minimum fresh air to 5%.

Savings: 39,700 CFM x .05 x 1.08 x (68-28) x 28 wks. x 5 days x 8 hrs. = 96 MMBTU
@ $3.17/MMBTU = $304/yr.

First cost: Assume $200 to adjust and check out control.

Payback: 7.9 months

Note: Both units observed running on day cycle with only a few people in area, during week following end of school. All lights in area were also on.

Recommendations: When only a few people are in area, keep one unit off and do not turn other unit on until space temperature is over 78° . Keeping un-needed lights off will also lower space temperature. See Section 4 for lighting recommendations.

7. AC-3 Kitchen

Present operation: Unit is run on day cycle from 6:30 am - 3:15 pm M-F during school year.

- Single zone unit w/steam coil and DX cooling.
- Space stat controls steam coil and face and by-pass dampers. - Steam coil runs wild when outside temperature is below 35°.
- Space stat controls cooling unit.
- Night stat cycles unit on unit heater cycle.
- Fresh air damper interlocked with hood exhaust fans.

Recommendation: Disconnect interlock with exhaust fans and rely on damper leakage and air from cafeteria for make-up to exhaust hood. Relocate sensor from outside air to mixed air so coil will run wild only when mixed air temperature is below 35°.

Savings: Heat energy:

5,000 CFM x .90 x 1.08 x (68-28) x 28 wks. x 5 days x 8 3/4 hrs. = 238 MMBTU
@ $3.17/MMBTU = $754/yr.

Cooling energy:

5,000 CFM x .90 x 4.5 x 6 x 8 wks. x 5 days x 8 3/4 hrs. x 50% = 1,772 ton-hrs.
@ $1.4 KW/ton-hr. = 2,481 KWH/yr.
@ $.018/KWH = $45/yr.

First cost: Assume $200 to modify control and check out control system.

Payback: 3 months

8. S-1 and S-2 Gym

Present operation: Units run on day cycle from 6 am - 11 pm M-F during school year. Both units are run at same time because there is a problem with pressurizing one side of movable partition and moving partition when only one unit is run.

- Built-up units with steam coils in supply ducts.
- 10% minimum fresh air after warm-up - additional air brought in after steam valves have modulated closed.
- Unit heater cycle at night.

Recommendations:

(a) Check for proper operation of controls and make sure relief dampers and fans are operating as designed. It should be possible to run only unit S-1 unless there are large crowds.

Savings: Fan energy: Assume unit S-2 is needed an average of 10 hrs./wk.

10 HP x .746 x 36 wks. x 75 hrs. = 20,142 KWH/yr.
@ $.018/KWH = $363/yr.

Heat energy:

30,000 CFM x .10 x 1.08 x (68-28) x 28 wks.
x 75 hrs. = 272 MMBTU
@ $3.17/MMBTU = $862/yr.

First cost: $500

Payback: 4.9 months

(b) Reduce unit S-1 minimum fresh air to 5%.

Savings: 20,000 CFM x .05 x 1.08 x (68-28) x 28 wks.
x 85 hrs. = 103 MMBTU
@ $3.17/MMBTU = $327/yr.

First cost: Assume $200 to adjust and check out control.

Payback: 7.3 months

9. S-3 Pool spectator area

Present operation: Unit is run only when large crowds are present. - Approximately 100 hrs./yr.

Recommendations: None

10. S-3a Pool

Present operation: Unit runs continuously 11 months/yr.

- Single zone unit w/steam preheat and reheat coil.
- Preheat coil valve is open when outside temperature is below 35°.
- Reheat coil valve controlled by space stat.
- System has rotary heat exchanger wheel.
- System designed to be off when on night cycle, except space humidistat will return unit to day cycle when humidity exceeds its setting.

Recommendations: Turn unit to night mode during unoccupied hours. Assume unit will run 25% of the time while in night mode.

Savings: Fan energy:

7 1/2 HP x .746 x (36 wks. x 95 hrs. + 12 wks. x 108 hrs.) x .75 = 19,790 KWH/yr.
@ $.018/KWH = $356/yr.

Heat energy: Assume 70% efficiency for heat exchanger.

12,000 CFM x 1.08 x (80-36) x 36 wks. x 95 hrs. = 439 MMBTU
@ $3.17/MMBTU = $1,392/yr.

First cost: None

Payback: Immediate

11. S-4 Gymnastics & S-5 Wrestling

Present operation: Units run on day cycle from 6 am - 11 pm M-F during heating season.

- Single zone H & V units w/steam coils.
- 10% minimum fresh air after warm-up cycle - additional air brought in after steam valves have modulated closed.
- Unit heater cycle at night.
- Gymnastics occupied 7-6 and wrestling 9-3.

Recommendations: Run units on day cycle during occupied hours only.

Savings: Fan energy:

(5 HP x .746 x 28 wks. x 39 hrs.) x (1.5 HP x .746 x 28 wks. x 55 hrs.) = 4,856 KWH/yr.
@ $.018/KWH = $87/yr.

Heat energy:

(10,000 CFM x .10 x 1.08 x (68-28) x 28 wks. x 30 hrs.) + (3,300 CFM x .1 x 1.08 x (68-28) x 28 wks. x 55 hrs.) = 58 MMBTU
@ $3.17/MMBTU = $184/yr.

First cost: None

Payback: Immediate

12. S-6 Corridor & lobby

Present operation: Unit is run only when there are large crowds in area. - About 25 hrs./yr.

Recommendations: None

13. S-7 Cafeteria

Present operation: Unit is run on day cycle from 6 am - 4 or 5 pm M-F during school year.

. Single zone unit w/DX cooling.

. Two supply ducts with H.W. coil in each.

. 20% minimum fresh air after warm-up cycle.

. Night stat operates unit on U.H. cycle.

Recommendations:

(a) Do not turn unit to day cycle until 7 am and turn to night cycle at 3 pm.

Savings: Fan energy:

15 HP x .746 x 180 days x 2 1/3 hrs. = 5,035 KWH/yr.
@ $.018/KWH = $91/yr.

Heat energy:

24,000 CFM x .20 x 1.08 x (68-28) x 28 wks.
x 5 days x 2 1/2 hrs. = 73 MMBTU
@ $3.17/MMBTU = $231/yr.

Cooling energy:

24,000 CFM x .20 x 4.5 x 6 x 50% average
load x 6 wks. x 5 days x 1 1/2 hrs. = 243 ton-hrs.
@ 1.4 KW/ton-hr = 340 KWH
@ $.018/KWH = $6/yr.

First cost: None

Payback: Immediate

(b) Reduce minimum fresh air to 10%.

Savings: Heat energy:

24,000 CFM x .10 x 1.08 x (68-28) x 28 wks.
x 5 days x 8 hrs. = 116 MMBTU
@ $3.17/MMBTU = $368/yr.

Cooling energy:

24,000 CFM x .10 x 4.5 x 6 x 50% average
load x 6 wks. x 5 days x 8 hrs. = 648 ton-hrs.
@ 1.4 KW/ton-hr. = 907/KWH
@ $.018/KWH = $16/yr.

First cost: Assume $200 to adjust & check out control.

Payback: 6.2 months.

14. S-8 Music & S-9 Ceramics

Present operation: Units run on day cycle 6:30 - 3:15 M-F during school year.

- Single zone units w/DX cooling.
- H.W. coils in supply ducts.
- Space stats control heating coil.
- 2-stage cooling stats control cooling units.
- 10% minimum fresh air after warm-up - admit more fresh air if supply temperature exceeds 60°.
- Night stats cycle units on unit heater cycle.

Recommendations:

(a) Vary time of switching to day cycle with outside temperature. During moderate weather, units should be switched to day cycle at 8 am.

Savings: Fan energy: Assume 1/2 hr. reduction in running time in Dec., Jan., Feb., 1 hr. in Nov. and March and 1 1/2 hrs. in Sept., Oct., April and May.

12.5 HP x .746 x (12 wks. x 5 days x 1/2 hr. + 8 wks. x 5 days x 1 hr. + 16 wks. x 5 days x 1 1/2 hrs.) = 1,772 KWH/yr.
@ $.018/KWH = $32/yr.

Heat energy:

13,200 CFM x .10 x 1.08 x [(68-16 x 30 hrs.) + (68-36 x 40 hrs.) + (68-53 x 8 wks. x 5 days x 1 1/2 hrs.)] = 5 MMBTU
@ $3.17/MMBTU = $16/yr.

First cost: None

Payback: Immediate

(b) Reduce minimum fresh air to 5%.

Savings: 13,200 CFM x .05 x 1.08 x (68-28) x 28 wks. x 5 days x 8 hrs. = 32 MMBTU
@ $3.17/MMBTU = $101/yr

Cooling energy:

13,200 CFM x .05 x 4.5 x 6 x 50% average load x 6 wks. x 5 days x 8 hrs. = 178 ton-hrs.
@ 1.4 KW/ton-hr. = 249 KWH
@ $.018/KWH = $4/yr.

First cost: Assume $200 to adjust & check out controls.

Payback: 1.9 yrs.

15. S-10 Boiler room

Present operation: Unit runs continuous during school year.

. Combustion air unit w/steam preheat and reheat coils.

. 33% fresh air when 1 boiler is on, 66% when 2 are on and 100% when 3 are on.

. Maintenance engineer discovered that dampers have not been closing and is going to correct this.

Recommendations: Repair control system as required to make it function as designed.

Savings: Assume an average of 50% reduction in fresh air.

15,000 CFM x .50 x 1.08 x (68-28) x 28 wks. x 7 days x 24 hrs. = 1,524 MMBTU
@ $3.17/MMBTU = $4,831/yr.

First cost: Assume $200

Payback: .5 months

16. HV-1 through HV-5 Shop units - 1963 building

Present operation: Units turned on/off locally by shop instructors.

. Horizontal auditorium type unit ventilators w/steam coils.

. Steam coils controlled by room stats.

. Room stats also control radiation.

. Dual temperature stats switched to day/night at panel in basement mech. room.

. Fresh air dampers appeared to be in good condition.

. Fresh air/return air dampers controlled by mixed air controls. - Controls have been adjusted to 65° or higher.

Recommednations: None

17. Classroom unit ventilation - 1963 + 66 building

Present operation: Units controlled from day/night switch in basement mech. room, 6 am - 3:15 pm M-F during school year.

. Vertical and horizontal units w/steam coils.

. Dual temperature space stats control steam coils and fresh air/return air dampers.

. Pre-determined minimum fresh air has been set back to 0%.

Recommendations: Vary time of switching to day cycle with outside temperature. Turn to night cycle at 3 pm.

Savings: Fan energy: Assume 1 1/2 hrs./day reduction in running time in Dec., Jan., Feb., 2 hrs. in Nov. and March and 2 1/2 hrs. in Sept., Oct., April, and May.

4.5 HP x .746 x (12 wks. x 5 days x 1 1/2 hrs. + 8 wks. x 5 days x 2 hrs. + 16 wks. x 5 days x 2 1/2 hrs.) = 1,242 KWH/yr.
@ $.018/KWH = $22/yr.

Heat energy: Assume 10% fresh air due to damper leakage.

36,500 CFM x .10 x 1.08 x [(68-16 x 90 hrs.) + (68-36 x 80 hrs.) + (68-53 x 8 wks. x 5 days x 2 1/2 hrs.)] = 34 MMBTU
@ $3.17/MMBTU = $108/yr.

First cost: None

Payback: Immediate

18. AC unit - Administration area - 1963 building

Present operation: Unit is run on day cycle from 6 am - 3:15 pm year round.

- Single zone air handling unit w/steam coil and DX cooling coil.
- Reciprocating compressor with evaporation condenser.
- Fresh air/return air dampers controlled by mixed air controller.
- Discharge stat control heating coil.
- Return air stat controls cooling coil.

Recommendations: Vary time of switching to day cycle with outside temperature.

Savings: Fan energy: Assume 1 hr/day reduction in running time in Dec., Jan., Feb., 1 1/2 hrs. in Nov. and March and 2 hrs. remainder of year.

1 1/2 HP x .746 x (12 wks. x 5 days x 1 hr. + 8 wks. x 5 days x 1 1/2 hrs. + 30 wks. x 5 days x 2 hrs.) = 470 KWH/yr.
@ $.018/KWH = $8/yr.

Heat energy: Assume 10% fresh air due to damper setting and/or leakage.

5,400 CFM x .10 x 1.08 x [(68-16 x 60 hrs.) + (68-36 x 60 hrs.) + (68-53 x 8 wks. x 5 days x 2 hrs.)] = 4 MMBTU
@ $3.17/MMBTU = $13/yr.

First cost: None

Payback: Immediate

19. AC unit - Board room - 1963 building

Present operation: Unit controlled by thermostat in board room and used occassionally when office unit is not able to handle load

. Roof-top cooling only unit.

Recommendations: None

20. Welding shop unit

Present operation: Used during heating season only and is controlled by shop instructor. Generally on from 9 am - 3:15 pm M-F. Unit has heat recovery wheel.

Recommendations: None

21. H&V unit #3 (Power shop), #4 (Auto shop), #5 (Synthetic shop) and #6 (Print shop)

Present operation: Units controlled by shop instructor and generally on from about 7 am to 3:15 M-F during school year. Custodians make sure units are off at night.

. Single zone units w/steam heating coils.

. Unit #6 also has DX cooling.

Recommendations: None

22. Home Ec. unit

Present operation: Unit is run on day cycle from approximately 7 am - 3:30 pm M-F during school year.

. Multi-zone unit with steam heating coil and DX cooling.

. Air cooled condensing unit.

. No plans or specs available for this unit.

Recommendations: None

D. Exhaust fans

1. Toilet exhaust fans 5, 6 & 14 - 1963 building

Present operation: Fans turned on by custodians at 7 am and off 3-4 pm. Left on continuously when below 10°.

Recommendations: Delay starting time until 8 am.

Savings: Fan energy:

3/4 HP x .746 x 24 wks. x 5 days x 1 hr. = 67 KWH/yr.
@ $.018/KWH = $1/yr.

Fuel:

4,700 CFM x 1.08 x (68-43) x 20 wks. x 5 days
x 1 hr. x .5 = 6 MMBTU
@ $3.17/MMBTU = $19/yr.

First cost: None

Payback: Immediate

2. Chemistry exhaust fan - 1963 building

Present operation: General exhaust added to serve chemistry and dark room. Sign at switch "leave fan on".

Recommendation: Turn fan off at night and on weekends.

Savings: Fan energy:

1/8 HP x .746 x 36 wks. x (5 days x 16 hrs.
+ 48 hrs.) = 430 KWH/yr.
@ $.018/KWH = $8 /yr.

Fuel:

1,200 CFM x 1.08 x (68-28) x 28 wks. x (5 days
x 16 hrs. + 48 hrs.) x .50 = 93 MMBTU
@ $3.17/MMBTU = $295/yr.

First cost: None

Payback: Immediate

3. Toilet exhaust fans #1, PV-7, #2 & #14

Present operation: Fans run continuously M-F during school year.

Recommendations: Turn fans off during unoccupied hours.

Savings: Fan energy:

1.38 HP x .746 x 36 wks. x 4 days x 14 hrs. = 2,075 KWH/yr.
@ $.018/KWH = $37/yr.

Heat energy:

6,115 CFM x 1.08 x (68-28) x 28 wks. x 4 days
x 14 hrs. x .5 = 207 MMBTU
@ $3.17/MMBTU = $656/yr.

First cost: None

Payback: Immediate

4. Locker room exhaust fan

Present operation: Fan runs from 11 pm Sunday - 5 pm Saturday during school year and 7 am - 11 pm M-F during summer (2 months).

Recommendations: Turn fan off during unoccupied hours.

Savings: Fan energy:

1 HP x .746 x (60 hrs. x 36 wks. + 20 hrs. x 8 wks.) = 1,731 KWH/yr.
@ $.018/KWH = $31/yr.

Heat energy: Included in Section C5.

First cost: None

Payback: Immediate